Intertrial reinforcement and the partial reinforcement effect as a function of number of training trials

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Abstract

An experiment involving rats in a runway, intertrial reinforcement and three successive acquisition-extinction sequences substantiated and extended earlier findings that intertrial reinforcement diminished the partial reinforcement effect following a small number of acquisition trials, but not after extensive training.

Problem

Capaldi, Hart, & Stanley (1963) and Capaldi & Spivey (1963) have shown that reinforced goal box placement (ITR) following nonreinforced (N) trials that preceded reinforced (R) trials greatly diminished or eliminated the partial reinforcement effect (PRE) following 30 acquisition trials. McCain (1964) has reported similar results after five training trials only two of which were N trials. These results have been adduced as evidence for the hypothesis that PRE is due to the conditioning of stimulus aftereffects of nonreinforcement (S^N) to locomotor responses on subsequent R trials. Black & Spence (1965), however, found no decrease in resistance to extinction as a result of the ITR procedure when acquisition was extended to 96 trials.

The present study was designed to investigate the effects of ITR on the partial reinforcement effect within the same Ss during three successive extinction phases following: (1) 10 original acquisition trials, (2) 55 reconditioning trials and (3) 55 further reconditioning trials.

Method

The Ss, ranging in age from 90 to 120 days at the onset of experimentation, were 48 hooded rats from the colony maintained by the Iowa Psychology Department. The apparatus consisted of a 43-in by 3 1/2-in by 4-in black alley, a 9-in by 2-in by 4-in grey start box and an 8-in by 12-in unfinished wooden intertrial-confinement box. The last 12 in of the alley was set off by a guillotine-type door to form a goal box which contained a glass caster 1 1/2 in in diameter and 3/8 in deep for presenting wet mash. The start box was separated from the alley by an inverted guillotine-type door and the entire apparatus was covered with transparent Plexiglas. Response speeds were measured by Hunter Klockcounters over the first foot (starting), the next 6 in (running) and a 1 ft distance 6 in on either side of the goal box door (goal).

Ss were maintained on 10 gm of Purina Lab Chow per day. Rations were given in the home cages 1 hr. after each day's experimental session. After 10 days of handling Ss were allowed to explore the unbaited runway in groups of three, 15 min. per day, for three

days. Every 3 min. each S was removed and immediately placed back into the apparatus at one of five selected points such that on a given day it entered the apparatus at each of the points in a predetermined random order.

The experimental procedure consisted of three successive sequences of conditioning trials, each of which was followed by 15 extinction trials. In the first acquisition period nine trials were given on the first experimental day, followed by 1 R and 15 N trials on Day 2. Three days later, six days of nine training trials each were given, followed on Day 11 by 1 R and 15 N trials. On Day 14 a third six-day training period began, which was again followed by 1 R and 15 N trials on Day 20. All training trials involved 30 sec. in the goal box and then a 30-sec. intertrial interval (ITI). On trials followed by ITR, the first half of the ITI was spent in the confinement and the second half in the baited goal box. On all other trials the entire ITI was spent in the confinement box. All extinction trials were followed by 15 sec. in the unbaited goal box and then a 30-sec. ITI in the confinement box. In extinction any S who did not traverse the entire runway within 60 sec. was removed to the confinement box and its time for that trial was recorded as 60 sec. Only five Ss reached this criterion.

Ss were assigned randomly to three groups, which differed only in respect to their treatment on training trials. On such trials Group C (continuous) was always reinforced by a 30-sec. exposure to wet mash. It was given ITR after the second, fifth and eighth trials of each training day. The partially reinforced groups (PN and PR) received five R and four N trials on each training day according to the schedule RNRNRRNR. Group PN received ITR on the same schedule as C, while PR was given ITR after the third, sixth and ninth trials of each training day. Thus, PR received ITR after R trials while PN always received it after N trials that preceded R trials. There were 16 Ss in each group following the second extinction period. Two Ss in Group C were lost. Their data for the first two extinction periods was retained, however, since it was homogeneous with the data of the rest of Group C.

Results

Individual starting, running and goal times were converted to speeds (ft/sec.). Although the results for the three measures differed somewhat, they showed more or less the same trends. For comparison purposes the running speed data are presented since Black & Spence and McCain reported this measure. The

Fig. 1. Mean running speeds in three successive extinctions.

studies from Capaldi's laboratory involved what amounted to a combination of all three measures. Figure 1 shows the running speed curves for the three extinction periods. The results in the first extinction replicated the findings of McCain in showing the PRE effect in Group PR and also in the elimination of this effect when ITR was given following N trials as in Group PN.

Since in several instances the acquisition performance levels for the three groups differed significantly, a rate-of-extinction statistic (Anderson, 1963, equation 5) was calculated for each S, on each speed measure and in each extinction sequence. For purposes of this calculation, the asymptotes of extinction were estimated to be .10, .60, and .40 ft/sec. for starting, running and goal speeds, respectively. A repeated-measures analysis of variance was carried out separately on the rate indices for each of the three speed measures. The levels of the within variable were the successive extinctions. In the case of running speed, Groups ($F=23.31$; $df=2,45$; $p<.001$) and Extinctions ($F=5.50$; $df=2,88$; $p<.01$) were significant, while the interaction was not. Multiple range tests applied to the Groups variable in the first extinction revealed that Group PR extinguished significantly slower than both Groups PN and C ($p<.001$), whereas the latter did not differ from each other ($p>.10$).

In the second and third extinction it is apparent that Group PN became increasingly more resistant to extinction. Even in the second period it is significantly more resistant than Group C ($p<.05$) while in the third period its rate of extinction did not differ significantly from that of Group PR ($p>.10$). Multiple range tests of the running-speed rates for the successive extinctions indicated that the extinction rate of Group PN became significantly slower, whereas there were no significant differences in the case of Groups C and PR. The finding of this final extinction period thus agreed with Black and Spence's results in showing no effect of ITR on PRE after a large number of acquisition trials (120).

In respect to starting speeds, Groups ($F=94.44$; $df=2,45$; $p<.001$) and Extinctions ($F=17.59$; $df=2,88$;

$p<.001$) were significant while the interaction only approached significance ($F=2.07$; $df=4,88$; $p<.10$). Multiple range tests indicated that in each of the three extinctions, PR extinguished slower than PN, which extinguished slower than C, with all differences significant beyond the .001 level. In the case of goal-speed rates, neither Groups, Extinctions nor the interactions were significant.

Discussion

The results of the first extinction not only confirm the findings of McCain (1964; 1965) but also add support to the generalization that the number of training trials required to produce PRE is inversely related to the magnitude of the reward employed. The finding of PRE with so few training trials and its elimination by the ITR procedure also lend further support to the Hullian stimulus-aftereffects hypothesis as modified by Capaldi and his associates. Within the framework of this hypothesis the decreasing effectiveness of ITR on extinction rate with increased amount of training might be accounted for in terms of discrimination by the Ss of the stimulus aftereffects of R and ITR trials with the consequence that ITR is no longer capable of replacing S^N with the aftereffect of reinforcement (S^R). Capaldi and Spivey's finding that the magnitude of the effect of ITR on PRE was less the greater the discriminability of the ITR box and the goal box indicates the effects of such differential conditioning. Another possible factor that might account for this decreased effectiveness of ITR with a large number of training trials is suggested by the frustration theory of Amsel (1958) and Spence (1960). After extended training the locomotor response would become strongly conditioned to the stimulus consequences (s_p) of anticipatory frustration responses that occur in the runway. This should have the effect of increasing the resistance to extinction of such groups as PN and PR, regardless of ITR.

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Note

1. The present experiment was conducted at the State University of Iowa. The last author is now at Hayward College.